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LONG-RANGE ICE OUTLOOK
EASTERN ARCTIC (1963)

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## ABSTRACT

Oceanographic and climatic data for the eastern Arctic were analyzed in terms of sea-ice growth during the past winter. These analyses, combined with observed ice conditions taken during the period 15 through 25 March 1963 and a comprehensive study of historical ice and climatic information, formed the basis for the 1963 Ice Outlook. Extensive evaluation of this information indicates that present ice conditions in the Labrador Sea and along the Newfoundland coast are nearly similar to those observed in 1959; the analogous year in the Thule approaches is 1956. Goose Bay and Itivdleq are expected to open later than normal, whereas Thule and Sondrestrom will open earlier than normal. Kulusuk should open near the normal dates.

In terms of the 1962 ice season, it is expected that Goose Bay and Thule will open about the same time as last year, whereas Sondrestrom and Itivdleq will open slightly later than they did in 1962. Kulusuk should be open to escorted shipping about a week earlier than last year but will not be able to receive unescorted shipping until mid-August, about 15 days later than in 1962.

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## I. INTRODUCTION

The Long-Range Ice Outlook for 1963 presents a written and graphic description of the expected ice conditions during the forthcoming Military Sea Transportation Service (MSTS) Arctic operations. Prognostic monthly ice charts showing the expected distribution of sea ice from mid-May through mid-August are presented.

Although a comprehensive ice survey was made from 15 through 25 March, the outlook is basically a historical and statistical approach to the problem of predicting long-range ice conditions. Initially, an evaluation of the oceanographic and climatic conditions affecting ice formation, growth, and drift during the past winter are made. A comparison is then made between these environmental conditions and similar historical data in conjunction with the severity of ice conditions experienced during the disintegration period for preceding years. This approach is complemented with the preliminary March aerial ice reconnaissance to develop knowledge of the general character of the ice. Utilizing the 30-day weather outlook issued by the U. S. Weather Bureau, ice conditions are projected for one month. Thereafter, the monthly charts are developed assuming environmental conditions will approach normal during the disintegration period. Place names used in the outlook are shown in figure 1.

## II. ANALYSIS OF ENVIRONMENTAL DATA

### A. Oceanography

A comprehensive study was made of the oceanographic, meteorological, and climatological parameters affecting the ice characteristics. At the time of heat budget reversal, the thermal and saline structure of the sea was measured at selected oceanographic stations. Air temperatures expressed in cumulative degree days of freezing, snow cover, and radiational cooling were considered to determine heat loss and resultant ice growth. Dates of theoretical initial ice formation and theoretical ice thickness on 15 March based on these computations are presented in figure 2.

### B. Climatology

Generally, the temperature regime of an area and the ice drift can be related to the mean sea level pressure pattern. This was done for the 6-month period prior to 15 March. The mean circulation during a considerable portion of the period was characterized by a westward displacement of the Icelandic low over Labrador resulting in anomalous southerly winds along the Labrador and west Greenland coasts and onshore flow along the eastern Baffin Island coast.

Although the ice drift vectors along the Labrador coast (figure 3) are from the north, it should be noted that these vectors are based on a 6-month average; and that the magnitude of the vectors are considerably less than normal, indicating the influence of the anomalous southerly winds in this region. In addition, air temperature observations available for maritime weather stations fringing the area were used to compute degree-day information which was then converted into ice thickness. Analysis of temperature and drift data indicates thinner-than-normal ice conditions throughout the majority of the area, especially along the west Greenland coast. Along the Labrador coast, ice thicknesses are near normal. Thicker-than-normal conditions are indicated only in Hudson Strait and in the Canadian Archipelago. The drift vectors also indicate heavy pressure ice should have developed in western Baffin Bay with relatively light pressure ice development along the Labrador coast and in eastern Baffin Bay.

## III. PRELIMINARY SURVEY OF ICE CONDITIONS

Preliminary ice reconnaissance was flown during the period 15 through 25 March 1963. One patrol aircraft from Argentia, Newfoundland, surveyed the ice in the Labrador Sea, Davis Strait, Baffin Bay, and Hudson Strait. The radar boundary in the Labrador Sea and data above 77°N were observed on Project BIRDS EYE flights. Data taken on U. S. Navy flights from Iceland, on Project BIRDS EYE flights, and on Danish reconnaissance missions have been consolidated to show the pack boundary along the east coast of Greenland. Results of this survey are shown in figure 5. Symbols and definitions used in this report conform to the latest World Meteorological Organization (WMO) format.

### A. Newfoundland and Labrador Coasts

Within the observed area southeast of Belle Isle, the pack consisted generally of seven- to nine-tenths total concentration with 10 percent of the total being young ice and the remainder thick winter. Floe size was predominantly medium with no vast floes observed. All thick winter ice was moderately (two-tenths) ridged with light (one-tenth) rafting on the young ice.

Within the observed area between Hamilton Inlet and Belle Isle, four- to seven-tenths concentration of thick winter ice was observed; small and medium floes predominated. Young ice and slush were observed throughout the area. Moderate ridging existed throughout. All ice was covered with lightly drifted snow.

North of Hamilton Inlet, fast ice extended along the entire Labrador coast, within all bays and coves, and generally seaward to the outer islands. Consolidated, moderately ridged thick winter ice predominated throughout with heavy ($\geq$ three-tenths) ridging in the vicinity of Cape Makkovik.

B. Hudson Strait

Within the observed portion of Hudson Strait, the pack was generally composed of consolidated ice made up predominantly of vast floes. It averaged 80 percent thick winter, 10 percent medium winter, and 10 percent young ice with moderate ridging and rafting of the young ice.

Within an area adjacent to the coast and approximately 25 miles wide between Big Island and Lower Savage Islands, the average concentration was nine-tenths. The age within this area was predominantly 50 percent thick winter and 50 percent medium winter ice, with less than one percent slush between floes. An east-west area of open water approximately 20 by 80 miles was observed off the southwest coast of Resolution Island.

C. Baffin Bay

1. Baffin Island Coast - Between northeastern Bylot Island and Cape Mercy fast ice extended seaward to the outer islands. The observed portion of Cumberland Sound had an extensive area of young ice with fast ice confined to small bays and inlets on the northeast and southwest shores. Fast ice extended from the coast to the outer islands within the remainder of the observed area to Loks Land. Within Frobisher Bay, fast ice extended northward from the island chain in mid-bay. Little fast ice was evident in the remainder of the Bay. Young ice was extensive in the northeastern portion with eight-tenths of medium winter in the southwestern portion.

Consolidated ice predominated throughout the area. The average age was 80 percent thick winter and 20 percent young. A few polar floes were observed near Cape Christian. Ridging was heavy in the northern portion and moderate south of 70°N. Circular areas, about 10 miles in diameter, containing ten-tenths young ice were observed off Henry Kater Peninsula and Ragged Point. All ice was covered with lightly drifted snow.

2. West Greenland Coast - Only that portion of the coast between 65°30' and 67°20'N was observed. Belts of slush extended 25 miles seaward. Further westward, the average concentration was eight-tenths, of which 30 percent was young and the remainder thick winter.

3. Central and Northern Baffin Bay - Consolidated ice, consisting predominantly of thick winter with secondary forms of medium winter and young, was observed throughout this area. Heavy ridging prevailed on the winter ice; moderate rafting prevailed on the young ice. A lead, averaging 2 miles in width and oriented northeast to southwest, was observed at 72°30'N, 63°W. Average concentration was five-tenths young and five-tenths slush. A large area of predominantly young ice, estimated to be a portion of the North Open Water, extended 25 miles off the coast between

Wolstenholme Island and Kap York. An ice-free area 5 miles in diameter extended northward from Saunders Island.

D. East Greenland

Only the pack boundary was observed along the east Greenland coast north of 65°N. However, it is estimated that onshore winds normally observed in this area have produced close or very close concentrations. From 60° to 65°N fast ice was observed in bays and inlets to the coastal islands with close pack extending seaward to the pack boundary. South of 60°N, Danish reconnaissance flights observed very open to close pack which extended to nearly 50°W. The ice was predominantly storis (remnants of fused pressure ridges of polar ice drifting southward from the Arctic Ocean).

IV. OUTLOOK

A. General

Ice conditions computed by environmental considerations and observed by preliminary reconnaissance were somewhat similar to those observed in 1959 in the Labrador Sea and in 1956 in the Thule approaches. With respect to monthly mean pressure patterns, some similarity exists between the prognostic mean sea level pressure chart for April 1963 and the observed monthly mean surface pressure chart for April 1957. Prognostic ice conditions for the period mid-May through mid-August are shown in figures 6 through 9. Predicted opening dates are listed in table 1. Generally, ice concentrations along the Labrador coast will be

TABLE 1

OPENING DATES FOR HARBORS

| Harbor | Concentration in Approaches and Harbor less than 8/10 | | Concentration in Approaches and Harbor less than 1/10 | |
|---|---|---|---|---|
| | Predicted | Normal | Predicted | Normal |
| Goose Bay | 25 June | 1 June | 10 July | 16 June |
| Itivdleq | 1 May | 17 April | 5 May | 28 April |
| Kulusuk | 20 July | 25 July | 15 August | 13 August |
| Sondre Stromfjord | 25 May | 21 May | 1 June | 6 June |
| Thule | 30 June | 1 July | 15 July | 25 July |

heavier than during 1962, whereas ice conditions along Baffin Island will be similar to those of last year. In northern and central Baffin Bay ice concentrations appear to be slightly lighter this year. Ice conditions will be somewhat heavier this year than last along west Greenland and slightly better this year along east Greenland.

1. Newfoundland-Labrador Sea - By mid-May in the area south of Hamilton Inlet, the ice should consist mostly of very open and close pack and is expected to remain offshore owing to east-southeast to southeast drift. Along the remainder of the Labrador coast, southward drift is expected to keep the close pack dominant in this area adjacent to a narrow band of fast ice.

From mid-May to mid-June, slow ice dissipation is expected off the Newfoundland and Labrador coasts owing to repeated incursions of ice from the north. By mid-June, patches of open and very open pack should remain parallel to the northern Newfoundland coast. Final dissipation of ice in the latter area is expected near the end of June.

By mid-June, close pack ice is expected to remain along the Labrador coast from a point southeast of Cartwright to about 60°N in response to dominant north to south wind drift. Southward drifting ice along the Labrador coast should keep the approaches to Goose Bay closed until about 25 June at which time less than eight-tenths ice concentration is expected to prevail. By 10 July the approaches to Goose Bay should be open to unescorted shipping. As indicated by the forecast, however, an occasional patch of very open pack may still be in the area. Along the remainder of the Labrador coast, patches of very open and open pack should remain until the end of July when final disintegration is expected.

2. Hudson Strait and Baffin Island Coast - By mid-May, close pack ice should predominate the area with fast ice in many bays and inlets. However, areas of very open pack should be present southeast of Big Island and along the north coast of Frobisher Bay. Owing to the light ice conditions observed for those areas and the absence of ice influx, close pack ice is expected to continue to predominate during June. However, the offshore pack should have narrowed considerably from Resolution Island to Cape Dyer. A shore lead is expected to form southeastward from Bylot Island to a narrow band of very open pack ice which should extend further southward past Cape Christian. The area of very open pack southeast of Big Island should remain.

By mid-July, the pack ice is expected to dissipate considerably, especially from Bylot Island to Cape Henry Kater where a large ice-free and very open ice area is expected. Ice of varied concentration should be in evidence along most of the Baffin Island coast while close ice should predominate in the offshore pack from Cape Dyer to Resolution Island.

The only ice remaining by mid-August is expected from Cape Dyer to the southern portion of Home Bay.

3. Central and Northern Baffin Bay - By mid-May, the North Open Water should be in evidence in the form of a very open pack area from 77°N to Smith Sound. During the following month, a rapid enlargement is indicated. Areas of open pack are expected along the southern limits of the North Open Water while close ice should remain in the central portion of Baffin Bay.

By mid-July, owing to the southward enlargement of the North Open Water along the Baffin Island coast and widening of the west Greenland lead, the characteristic close ice tongue in the central portion of Baffin Bay should be in evidence. By mid-August the central tongue consisting of close and open pack should have receded to 71°N while very open pack is expected to extend to 73°N.

4. West Greenland Coast - Northward advection of warm water, in conjunction with relatively few frost degree days accumulated to 15 March, and expected light northwestward drift indicate that the northward movement of the west Greenland lead should be accelerated during the ice disintegration season. Thus during mid-May ice-free conditions should extend to 72°N. By mid-June they should extend to 74°N. Ice over the Middle Passage is expected to reduce sufficiently in concentration by 30 June to permit escorted shipping to Kap York. Unescorted ice conditions are expected to prevail in the Middle Passage by 15 July.

5. East Greenland Coast - Onshore winds and southward currents are expected to keep close ice adjacent to the coast with little change in the pack until at least June. By mid-June, accelerated melting should be evidenced by a narrowing of the pack south of 64°N. By mid-July, melting and a net efflux of ice from the Kulusuk area should permit escorted shipping to that site by 20 July. Very open pack should continue to drift south of 65°N until about 1 August. By 15 August very open pack is expected adjacent to the coast northward of Kulusuk. However, patches of very open pack may continue to drift south to 65°N before melting.

B. Harbors

1. Goose Bay - The first signs of breakup in Goose Bay and Lake Melville should occur in early May when very open ice areas are expected to develop at the mouths of all rivers. Based on the near-normal frost degree day accumulations to 15 March, breakup of the fast ice is expected about mid-May, as well as development of an open water area immediately thereafter along the north shore of Lake Melville. By 25 May all ice in Lake Melville, Goose Bay, and Terrington Basin is expected to have disintegrated. As previously discussed, however, southward incursions of the offshore pack north of Hamilton Inlet are

expected to result in close pack in the approaches until 25 June - later than normal opening dates. These opening dates fall within 5 days of last year's opening dates. Unescorted shipping is not expected earlier than about 10 July.

2. Itivdleq - During the early ice reconnaissance flights, a large amount of fast ice with many cracks was observed in Itivdleq Fjord. This corroborated the relatively warm air temperatures observed in that area during winter. Based on limited historical knowledge, the fast ice in the site approaches will breakup by 1 May - somewhat later than normal. Unescorted shipping to the site should be possible by 5 May. Open dates should be about 10 to 14 days later than in 1962.

3. Sondre Stromfjord - Owing to a less-than-normal number of frost degree days accumulated this winter, the ice in Sondre Stromfjord should be about 10 inches thinner than normal; thus should become ice free earlier than usual. The seaward limit of fast ice presently at Kap Look should recede to Kap Robinson about 20 May. The latter ice is expected to disintegrate about 25 May. By 1 June the fjord is expected to become essentially ice free. This is about one week later than last year.

4. Thule - Fast ice in North Star Bugt is expected to become well puddled by the end of June and to break up earlier than normal on about 5 July owing to the relatively few frost degree days accumulated during the winter season. Offshore, the North Open Water is expected to enlarge rapidly and to extend to Kap York by 1 July. Light northwestward drift is expected to keep close ice over Melville Bugt until 30 June when the Middle Passage is expected to become open to escorted shipping. Unescorted shipping should be possible by about 15 July or about 2 to 5 days later than in 1962.

5. Kulusuk - Constant southward advection of storis ice and onshore drift is expected to keep the approaches congested with close ice until 20 July. At this time escorted shipping should be possible - 5 days earlier than last year. Very open and open pack should continue to drift southward past Kulusuk until about mid-August when unescorted shipping may be expected, or about 15 days later than in 1962. Open dates for this port are expected to be relatively close to normal.

## V. GENERAL INFORMATION

### A. Brief on Icebergs

Iceberg frequency and major drift are shown graphically in figure 10.

The glaciers of Greenland are the source of almost all bergs encountered in the area. Because of their great draft, bergs tend to be more responsive to deep currents than they are to surface winds.

Accordingly, nearly all icebergs sighted south of 65°N along west Greenland originate from glaciers on east Greenland and tend to move southward along the southeastern coast of Greenland, northward along west Greenland, and southward along the Baffin Island and Labrador coasts. The distance covered by bergs drifting along the southwestern coast of Greenland to southern Newfoundland is about 1,800 miles and requires about 3 years to traverse. However, most bergs disintegrate or are trapped in the many indentations along the Baffin Island and Labrador coasts, so that only about 1 in 20 bergs survive the journey.

Owing to offshore currents, the coastal area between Godthaab and Holsteinsborg is relatively free of icebergs. The heaviest concentration of bergs north of Holsteinsborg and Egedesminde occurs in the vicinity of Disko Bugt, especially during June and July. Accordingly, many of the bergs in Baffin Bay and in the western Labrador Sea are believed to originate from this area.

B. Freezeup Information

Freezeup information including dates of initial ice formation, as well as an average of all the dates at specific sites for a number of individual years, is presented in figure 11. The freezeup information applies to the immediate harbor or coastal sector of the site indicated. Although initial ice generally does not hamper shipping, the dates provided give some indication as to the beginning of freezeup in various areas and of the variability that exists from year to year.

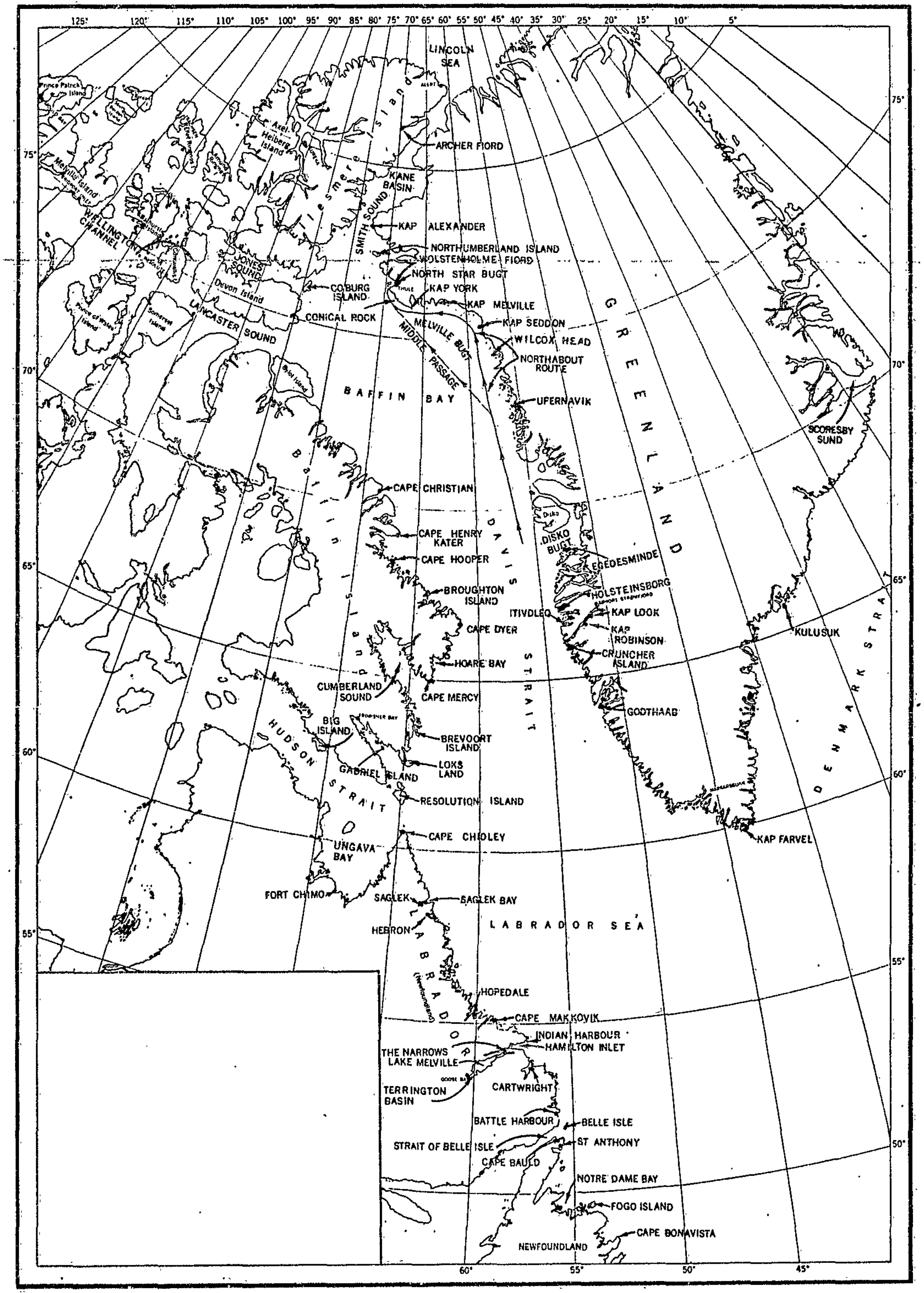


FIGURE I PLACE NAME CHART

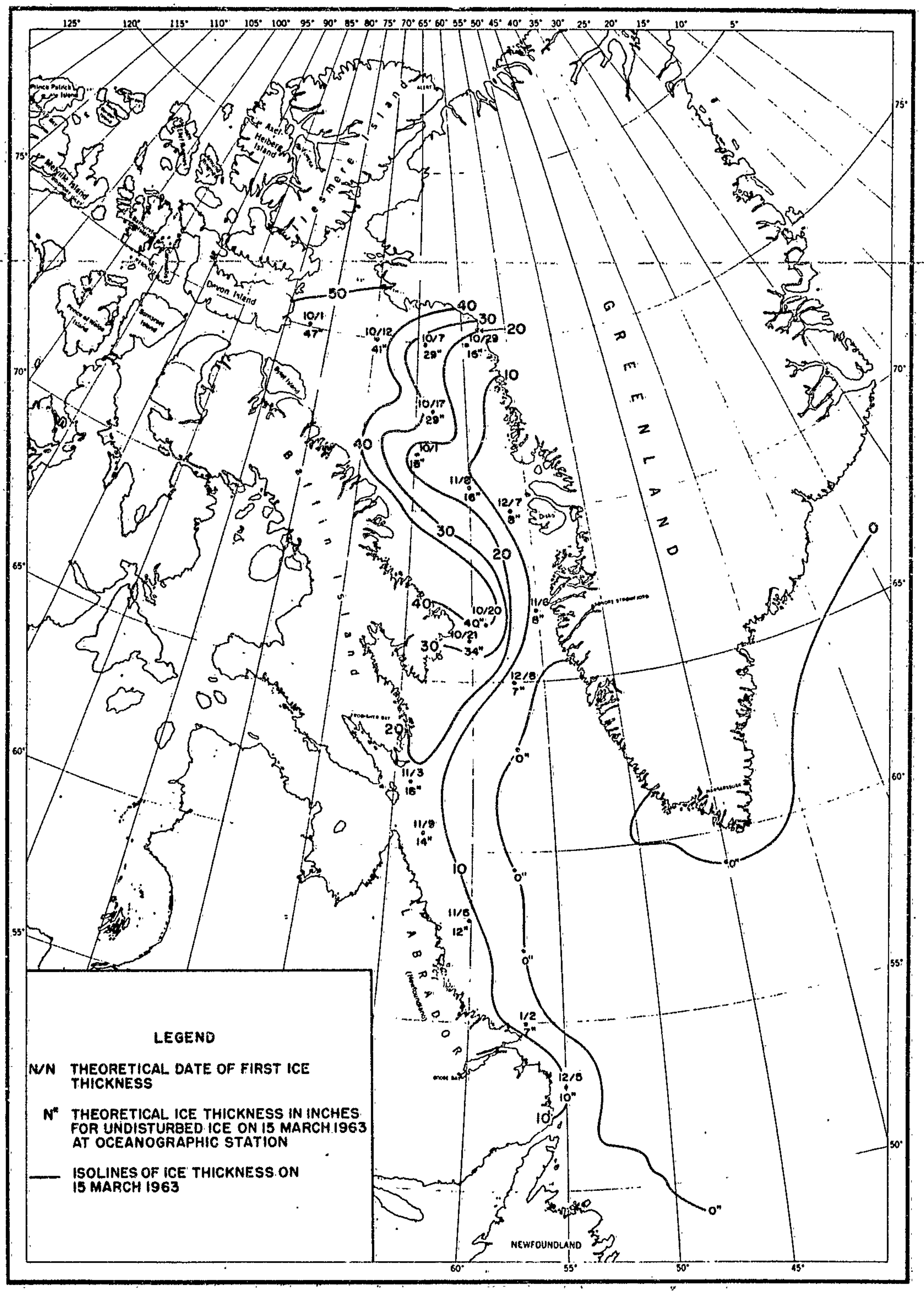


FIGURE 2 COMPUTED ICE THICKNESS FOR UNDISTURBED ICE ON 15 MARCH 1963

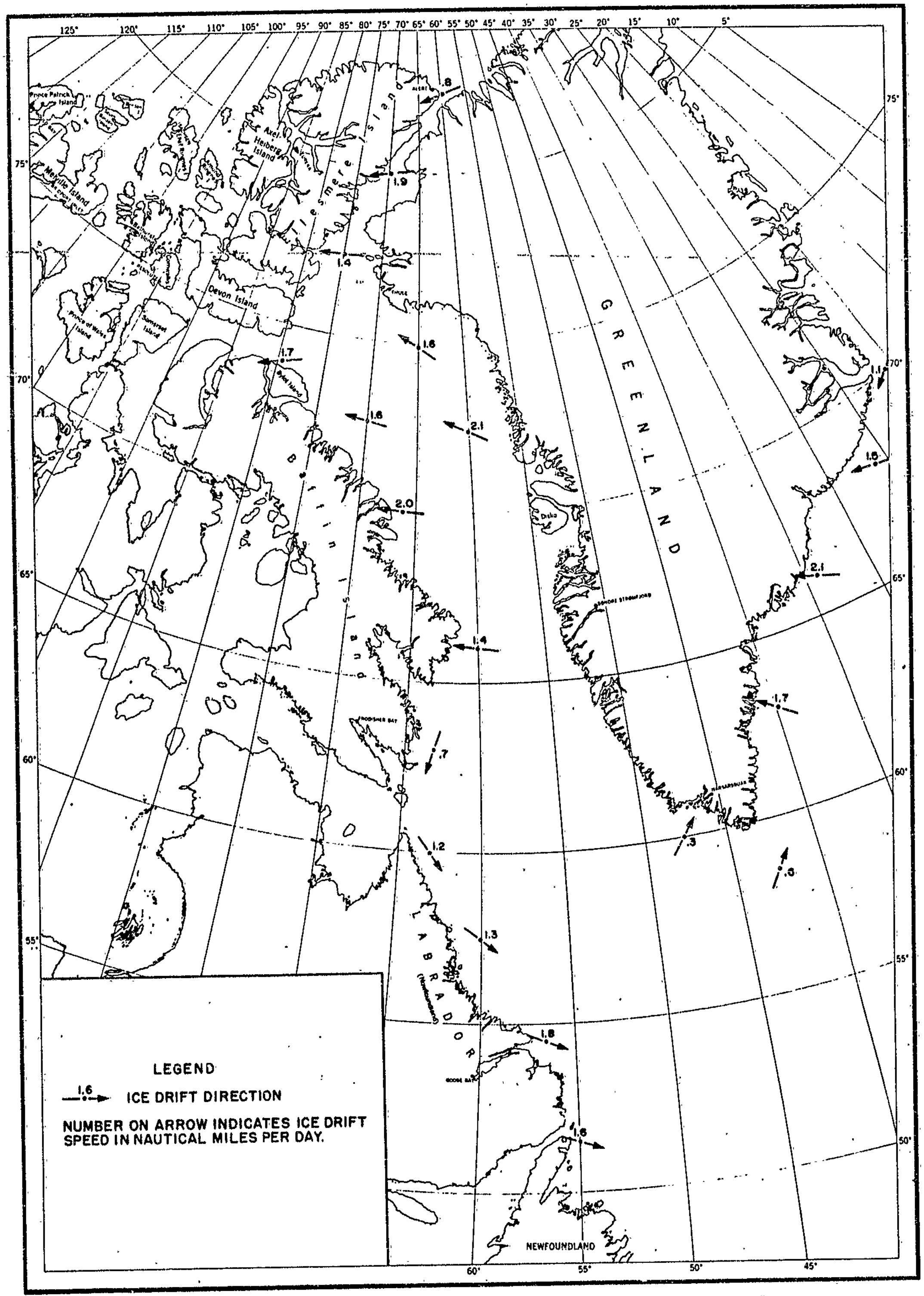


FIGURE 3 COMPUTED MEAN ICE DRIFT 15 OCTOBER 1962 THROUGH 15 MARCH 1963

# KEY TO ICE SYMBOLS

TOTAL CONCENTRATION

ICE FREE

0.1
(OPEN WATER)

0.1 THRU 0.3
(VERY OPEN PACK)

0.4 THRU 0.6
(OPEN PACK)

0.7 THRU 0.9
(CLOSE PACK)

1.0 (FAST OR
VERY CLOSE PACK)

COVERAGE BY SIZE

$\frac{Cn}{n_1\ n_2\ n_3}$

$n_1$ = tenths of slush, brash, and cakes

$n_2$ = tenths of small and medium floes

$n_3$ = tenths of big and vast floes

EXAMPLE: $\frac{7}{241}$

7 - TOTAL CONCENTRATION
2 - TENTHS ICE LESS THAN 30' ACROSS
4 - TENTHS OF FLOES (30'-3000')
1 - TENTHS OF FLOES (>3000')

BOUNDARY

OBSERVED

RADAR

LIMIT OF
OBSERVED DATA

STAGE OF DEVELOPMENT

$\frac{A}{\%PREDOMINANT,\ \%SECONDARY}$

IC = Crystals
SL = Slush
IR = Ice Rind
PK = Pancake
Y = Young
MW = Medium Winter
TW = Thick Winter
WT = Winter
PL = Polar
YP = Young Polar
AP = Arctic Pack

EXAMPLE: $\frac{A}{7MW3SL}$

A = Stage of Development
7 = 70% Medium Winter
3 = 30% Slush

THICKNESS OF ICE AND SNOW

$\frac{T}{n}$ = Ice Thickness (inches)

$\frac{SD}{n}$ = Snow Depth (inches)

PHENOMENA SYMBOLS

CRACK

POLYNYA

LEAD

(n) ICEBERGS

(n) BERGY BITS & GROWLERS

(n) = number in area

TOPOGRAPHY

RAFTED

RIDGED

HUMMOCKED

EXAMPLE: - +

+ After symbol indicates average height 10 ft or greater

- After symbol indicates average height less than 10 ft

(n) tenths coverage in area

STAGE OF MELTING

$\frac{PD}{(n) + (n)\ F}$

PD = Puddling - tenths value entered under the "PD" unless frozen or rotten

EXAMPLE: $\frac{PD}{3}$ = 3 tenths puddling

$\frac{PD}{3F}$ = 3 tenths frozen puddles

(n) = tenths coverage in area

(n) F = tenths coverage in area, frozen

$\frac{TH}{n}$ = Thaw Holes - same entry procedure as above

$\frac{S}{n}$ = Snow cover in tenths

UNDERCAST

Limit

FIGURE 4 LEGEND FOR FIGURE 5

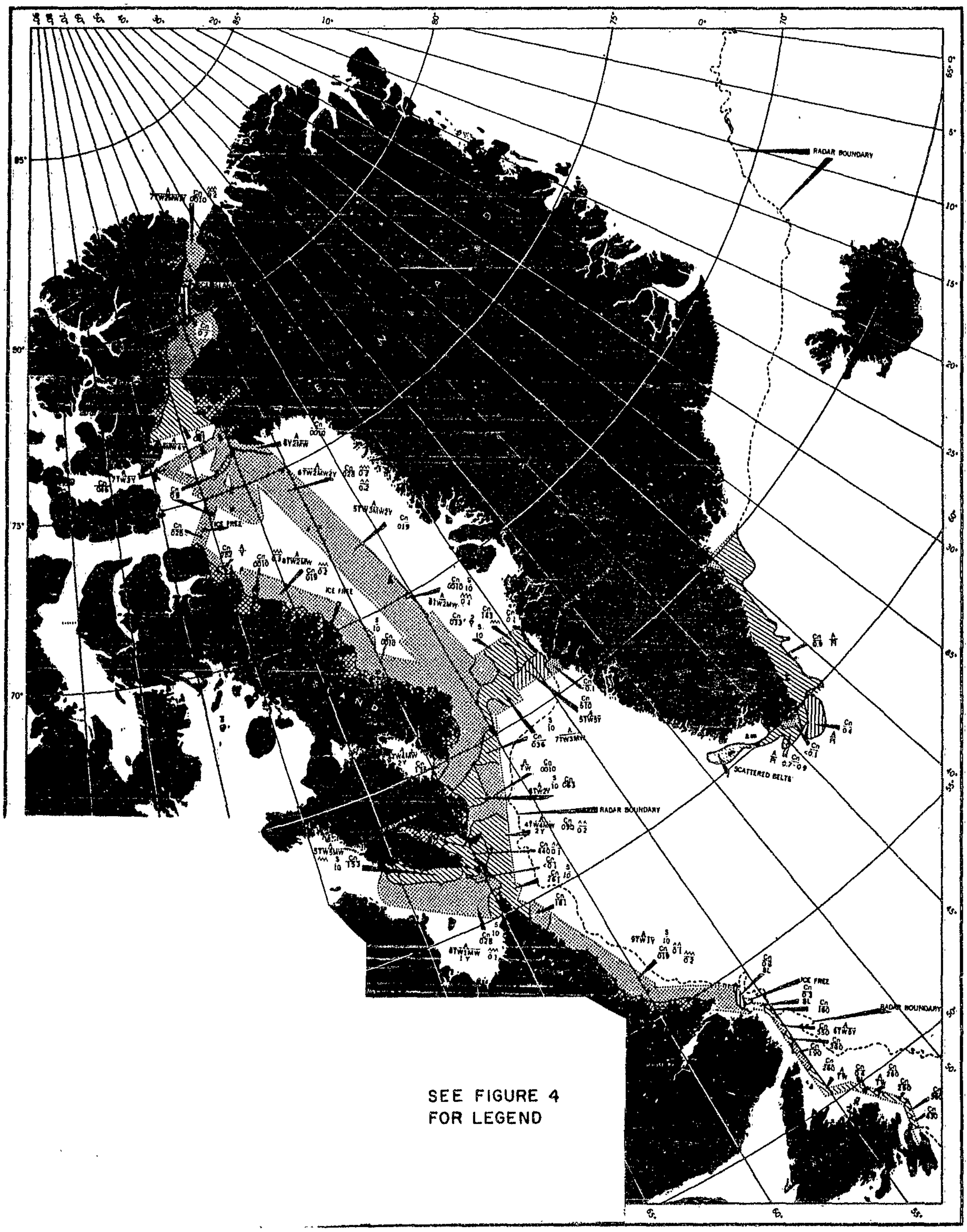


FIGURE 5 OBSERVED ICE CONDITIONS 15–25 MARCH 1963

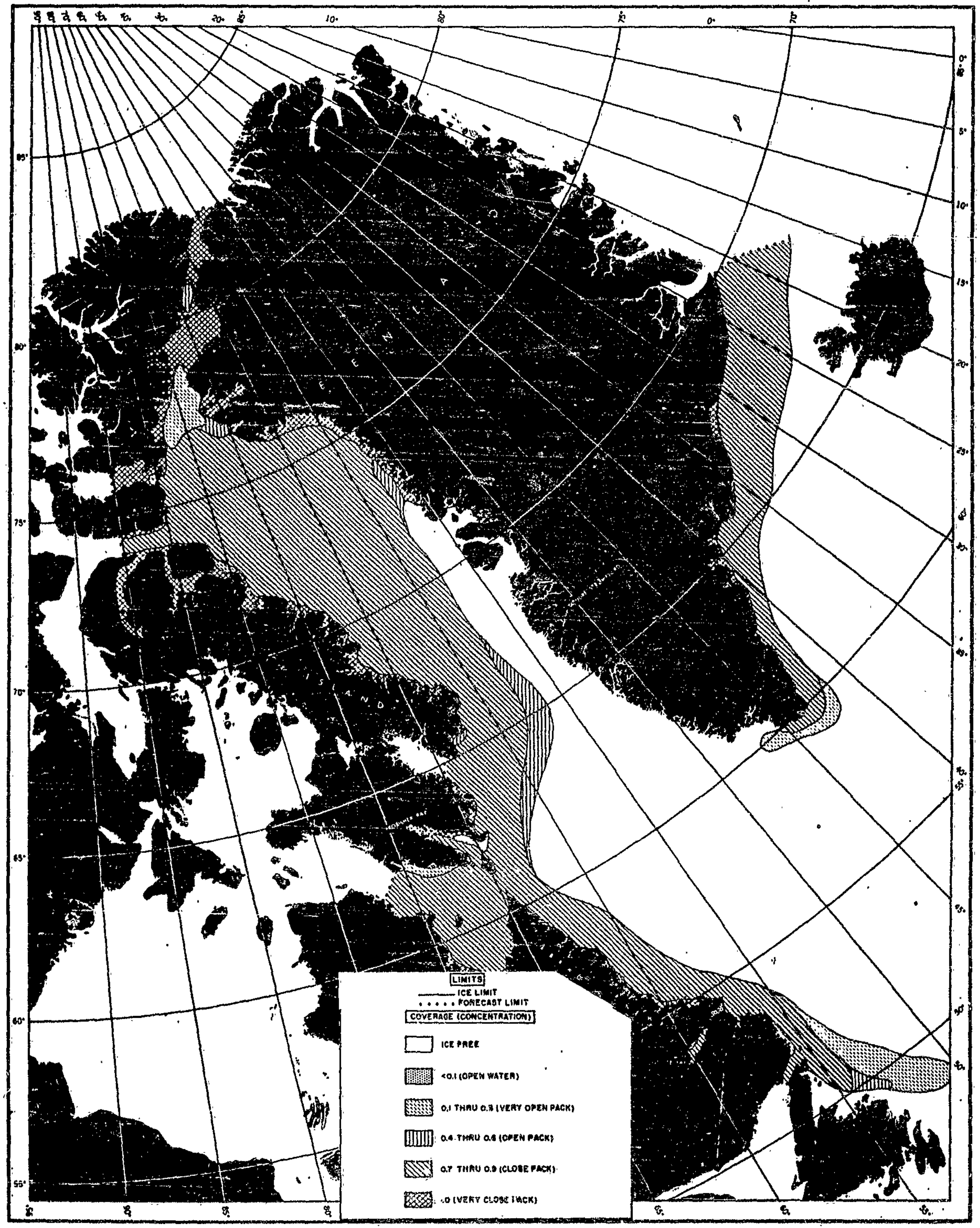


FIGURE 6 PROGNOSTIC ICE CHART MID-MAY 1963

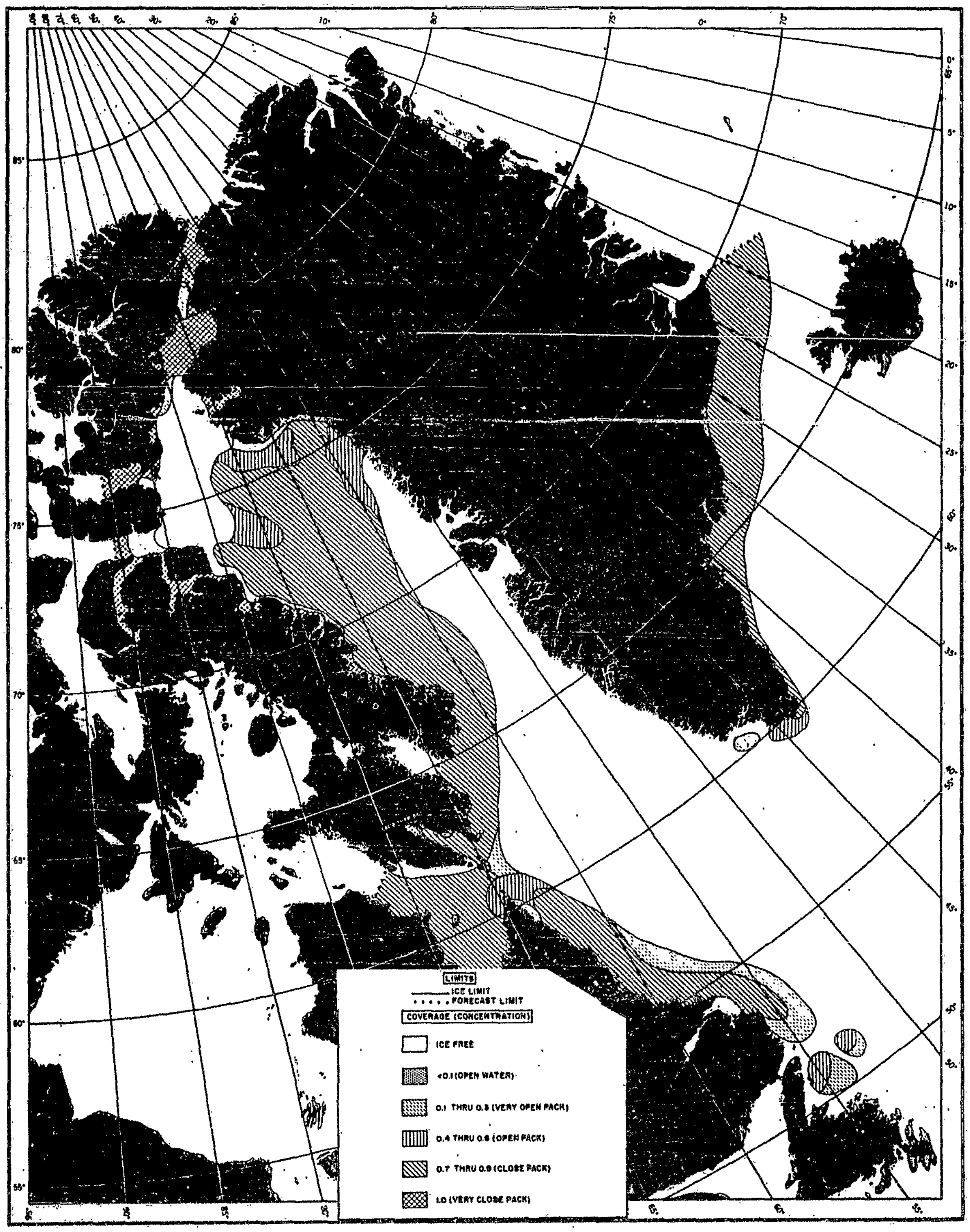


FIGURE 7 PROGNOSTIC ICE CHART MID-JUNE 1963

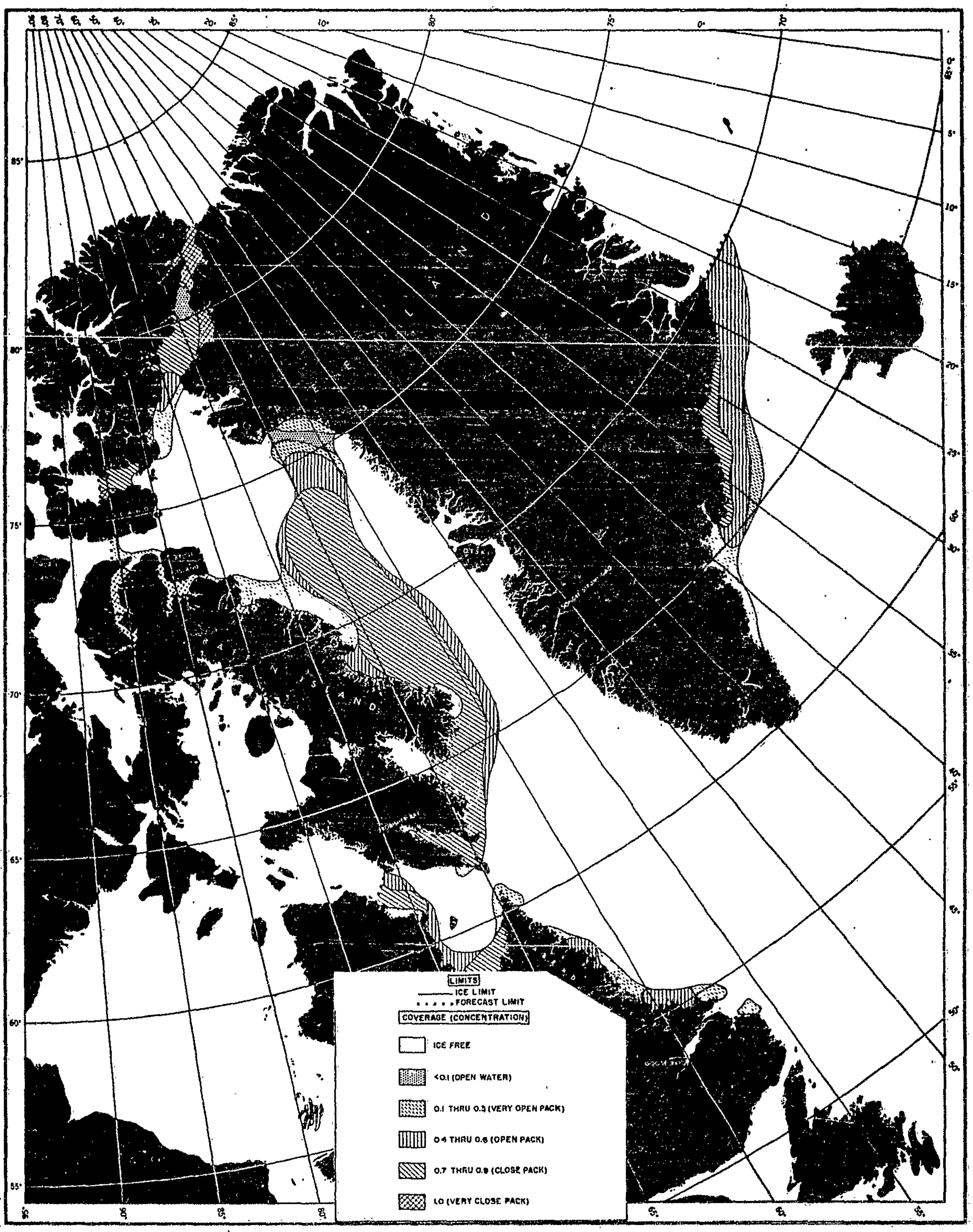


FIGURE 8 PROGNOSTIC ICE CHART MID—JULY 1963

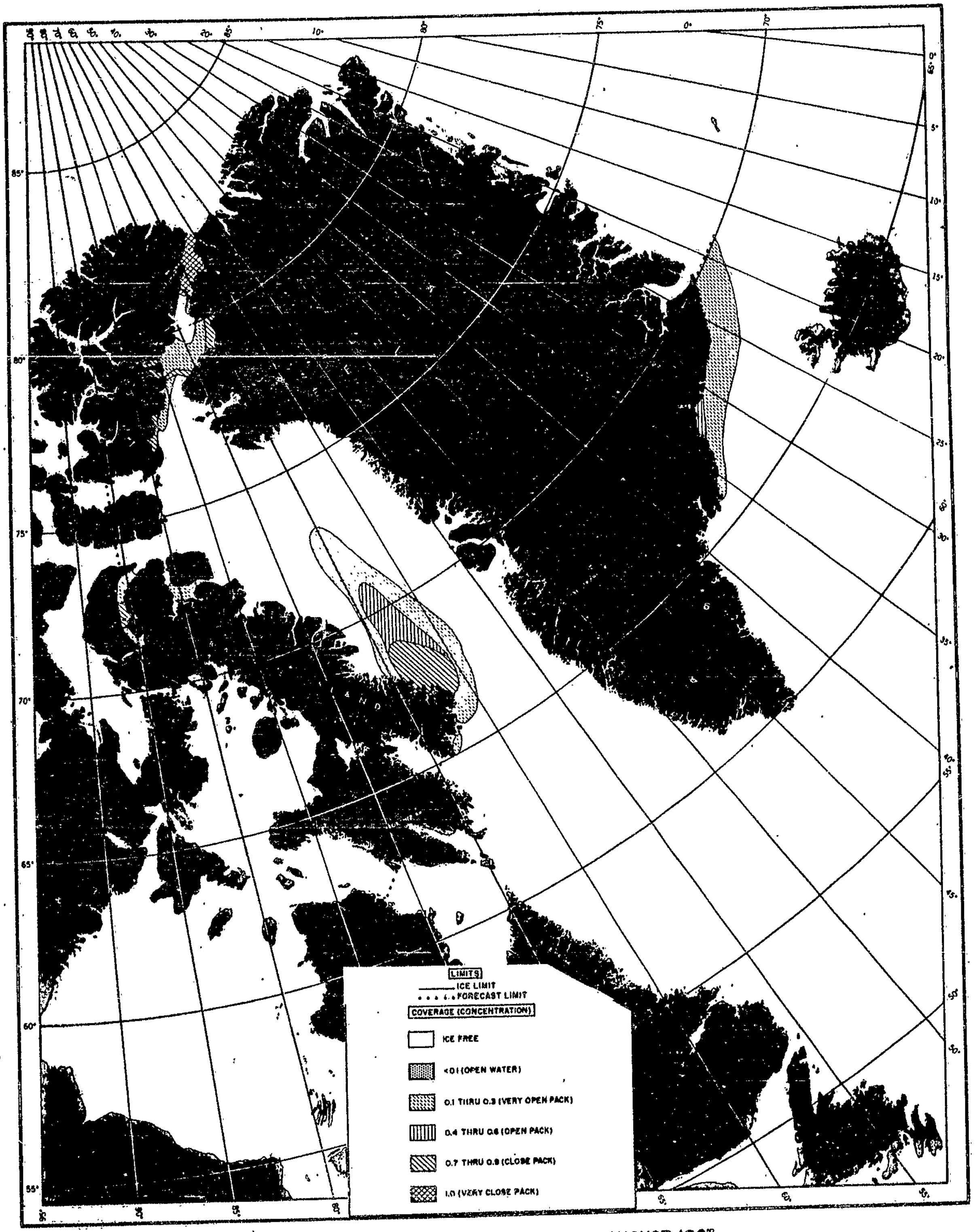


FIGURE 9 PROGNOSTIC ICE CHART MID-AUGUST 1963

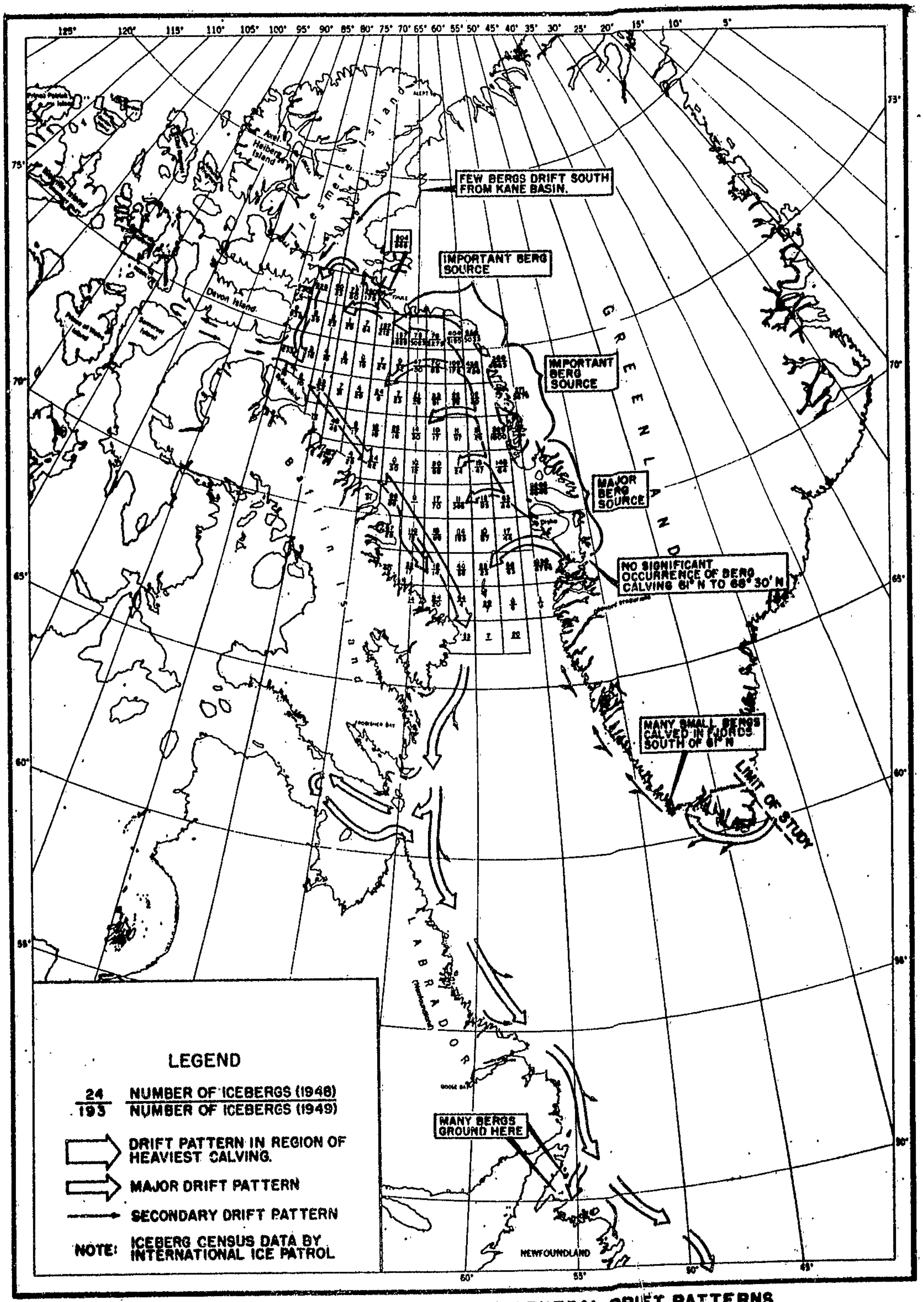


FIGURE 10 ICEBERG CENSUS DATA AND GENERAL DRIFT PATTERNS

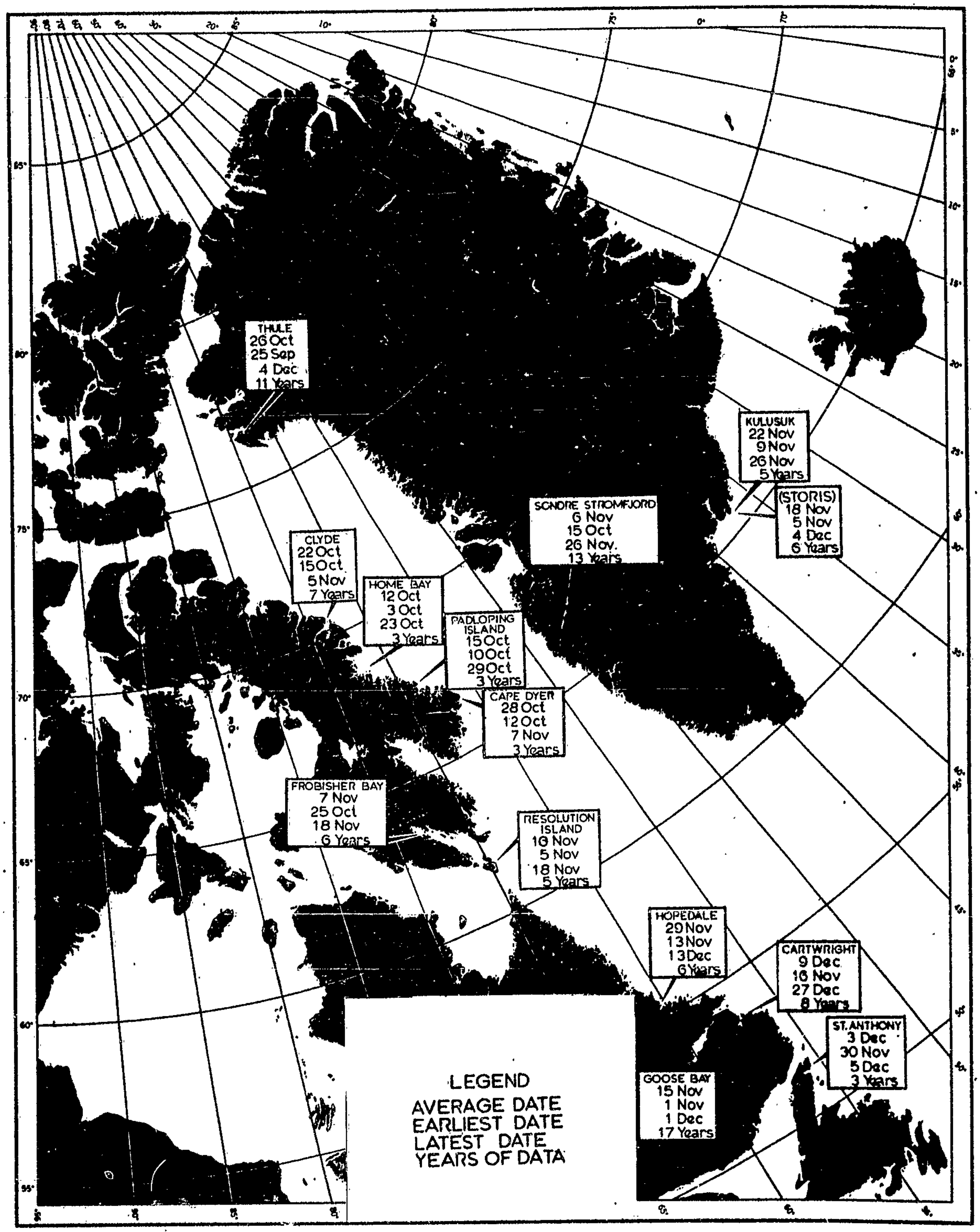


FIGURE 11 DATES OF INITIAL FREEZEUP